Environmental Studies Program: Studies Development Plan | FY 2024–2025

Field	Study Information
Title	Future Directions of Physical Oceanography Research on Offshore Renewable Energy Development at the Bureau of Ocean Energy Management
Administered by	Office of Environmental Programs and Office of Renewable Energy Programs
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Procurement Type(s)	Contract
Performance Period	FY 2024–2025
Final Report Due	TBD
Date Revised	May 12, 2023
Problem	The development of offshore renewable energy could potentially change the physical characteristics and processes in the lease areas of the Outer Continental Shelf (OCS), resulting in changes in the bio-geo-chemical processes and having implications on marine ecosystems, fisheries, and marine mammals.
Intervention	Understanding the impacts of offshore renewable energy development on Physical Oceanography (PO) is the foundation for understanding the potential environmental impacts on other oceanographic processes and is crucial for writing the environmental impact statements and environmental assessments as a requirement for the National Environmental Policy Act (NEPA) prior to any renewable energy lease sales in the OCS.
Comparison	A workshop to address the challenges and opportunities that BOEM's PO research encounters in the emerging needs of assessing the impacts of the offshore renewable energy development on physical and other oceanographic processes in the OCS leasing areas.
Outcome	A workshop and synthesis report to help BOEM better strategize its approach in addressing the emerging short-term and long-term physical oceanography information needs for offshore renewable energy development NEPA assessment.
Context	All OCS regions

BOEM Information Need(s): As one of the three federal departments (U.S. Departments of the Interior, Energy, and Commerce) responsible for deploying 30 Gigawatts of offshore wind energy by 2030, BOEM has established an ambitious goal of completing at least 16 Construction and Operations Plans by 2025, generating about 19 GW of clean energy (FS, 2021). BOEM conducted several offshore wind energy lease sales in the Atlantic and Pacific OCS and is planning to conduct lease sales in the Gulf of Mexico (GOM) OCS in the near future. BOEM assesses the potential environmental impacts of commercial scale offshore wind farms as part of Bureau's responsibilities under the National Environmental Policy Act (NEPA). The impact of these wind farms on the physical processes is the first and most important factor to consider, because physical processes (temperature, salinity, density, pressure, etc.) and water

movements determine stratification of water columns, vertical mixing, transports of phytoplankton, larval dispersal, primary production, sound speed, and other oceanographic processes.

In 2021, BOEM completed a study, "Hydrodynamic Modeling, Particle Tracking and Agent-Based Modeling of Larvae in the U.S. Mid-Atlantic Bight (Johnson et al., 2021), which evaluated how, and to what extent, offshore wind farms affect the physical and biological processes in the Mid-Atlantic. However, a similar study conducted by NOAA Northeast Fisheries Science Center (Chen et al. 2021) has shown a much broad scale effect that wind farms have on the physical and oceanographic processes in the Mid-Atlantic Bight. NOAA Fisheries thus raised concerns over BOEM's 2021 study. BOEM has subsequently requested the National Academies establish a committee of experts to assess the potential impacts from offshore windfarms on marine hydrodynamics in the Nantucket Shoals region. The NASEM study on the Nantucket Shoals region will likely be completed in the fall of 2023. Rather than seeking the expert advice from NASEM for each individual OCS renewable energy lease sale, BOEM needs to develop a strategy and optimize its approach going forward. BOEM needs expert advice on how to use the best available information and conduct both modeling and observation studies to understand and define the extent of offshore wind farms effect on the physical and biological processes in potential lease areas within different OCS regions. BOEM needs to engage and partner with other federal, state agencies, non-profit organizations, private industry, and academies to address this challenge.

Background: BOEM and its predecessor Minerals Management Service (MMS) has a long history of conducting physical oceanography research through the Environmental Studies Program (ESP) since the ESP was first established in 1973. BOEM's physical oceanography has made substantial contributions to the scientific community as well as fulfilling BOEM's mission throughout the years (Li et al 2022; Lugo-Fernández, 2015) The last comprehensive review of BOEM's (MMS) physical oceanography research program was conducted by NASEM in 1990 (NRC, 1990). The current scientific consensus regarding the impacts of offshore wind energy development on oceanographic processes can be summarized as follows:

- North Sea: Satellite imagery analysis shows that turbid wakes of individual turbines are 30-150 m wide, a few km long, and aligned with tidal currents that could impact sediment transport (Vanhellemont and Ruddick, 2014). A review article by van Berkel et al. (2020) categorized wind farms in the North Sea and the Irish Sea into five dynamics regimes and summarized the findings on the impacts of offshore wind farms on hydrodynamics and wind field. The impacts can be local or regional depending on the regime. A recent modeling study shows that wind wakes can cause up to 10% changes in annual primary production at the offshore wind farms and extended to a larger region (Daewel et al., 2022). Another study also found that large-scale offshore wind farms can significantly reduce the air-sea heat fluxes with a net cooling of the lower atmosphere in the wind farm areas down to more than 2.0 Wm^{-2} on an annual mean basis (Akhtar et al., 2022). Several other studies, both modeling and observational, indicate that offshore wind farms (OSW) have impacts on the ocean dynamics , primary production, and marine ecosystems (Christiansen et al., 2022; Dorrell et al., 2022; Floeter et al., 2022).
- U.S. Atlantic Wind Energy Areas (WEAs): One high-resolution modeling study simulated in the summer of 2018 indicates a reduction of 3%-4% near-surface wind speed downstream of the wind farms (Golbazi et al., 2022). The authors suggested that future studies are needed to explore the offshore wind turbine effects in other seasons. There are no studies published so far on the effects of wind farms on primary production or ecosystems.

- U.S. Pacific WEAs: One modeling study, funded by the California Energy Commission, suggests a modest impact of OSW on coastal upwelling and nutrient supply (Raghukumar et al., 2022; Raghukumar et al., in review), which in turn has implications for ecosystem dynamics and fisheries. Because each OSW area is oceanographically and ecologically unique, scientific studies are needed for each OSW area within each OCS region (Lloret et al., 2022).

Objectives:

- Establish the consensus of state-of-the-art approach to address the impacts of the renewable energy development on physical and other oceanographic processes in the OCS lease areas that are unique to each OCS region.
- Identify research needs and limitations in the numerical modeling to evaluate the impacts and establish a network for sub-mesoscale observations of ocean currents, hydrography, and winds via Gliders, Lagrangian drifters and other instruments to validate high-resolution ocean models.
- Develop a strategy for BOEM's PO research on the development of renewable energy, including necessary modeling tools and ocean observations for model validation.
- Foster collaboration among federal and state government agencies, academic researchers, non-profit organizations, private industry, and other interested entities.

Methods: The NASEM will conduct a workshop in their facility in Washington, D.C. by inviting experts (domestic and international) from academia, federal and state government agencies, non-profit organizations, private industry, and other entities to present the relevant topics. BOEM's PO team will provide input in selecting the experts, attend the workshop, and participate in discussions. OEP managers will participate and present the overview of ESP at the workshop. The workshop is planned for 2-3 days with both in-person and virtual attendance. The NASEM should publish a peer reviewed synthesis report of the workshop that highlights the presentations of these speakers and provides recommendations for the path forward of BOEM's PO research.

Specific Research Question(s):

1. What is the status of research (domestic and international) on assessing impacts of offshore renewable energy development (e.g., offshore wind farms) on hydrodynamic and biogeochemical processes that could potentially lead to impacts on marine ecosystems, fisheries, and marine mammals?
2. What is the future approach that BOEM should adopt to improve current modeling efforts and to determine the sub-mesoscale observations needed to validate the high-resolution numerical models?
3. What physical oceanography research should BOEM conduct to protect BOEM's offshore renewable energy development as a result of climate change?
4. How to build BOEM's Physical Oceanography Research Program to be a leader in conducting research on development of offshore renewable energy to serve BOEM's mission?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

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